Decontamination of pork carcases with hot water or acidified sodium chlorite - a comparison in two Australian abattoirs

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Abstract

A decontamination trial on the effectiveness of hot water and acidified sodium chlorite (SANOVA™) treatment on TVC, *E.coli* and *Salmonella* spp. was undertaken on a total of 852 pork carcases prior to primary chilling in two pork abattoirs in Australia using belly-strip excision sampling. Test pigs were selected from herds with a known high level of on-farm *Salmonella* infection. For control carcases at Abattoirs A and B, mean $\log_{10}$ Total Viable Count was 4.06 and 3.00 cfu/gram compared with 1.81 and 2.09 cfu/gram, for hot water and 2.76 and 2.53 cfu/gram for SANOVA™ treated carcases, respectively. The prevalence of *E. coli* on control carcases at Abattoirs A and B was 92.9% and 69.3% compared with 9.8% and 21.3% for hot water and 12.5% and 30% for SANOVA™ treated carcases, respectively. The censored mean $\log_{10}$ *E. coli* concentrations for control carcases at abattoirs A and B was 0.89 and 0.46 cfu/gram, compared with -0.83 and -0.65 cfu/gram from hot water and -0.64 and -0.61 cfu/gram from SANOVA™ treated carcases, respectively. *Salmonella* was only isolated from carcases at Abattoir B. The prevalence of *Salmonella* on control carcases at Abattoir B was 16% compared with 2.7% for hot water and 7.0% for SANOVA™ treated carcases. The reductions in prevalence and mean $\log_{10}$ concentrations in the present trial were all found to be statistically significant ($p<0.001$) and indicate that carcase decontamination with either hot water or SANOVA™ are effective risk management options immediately available to the pork industry.

Introduction

In industrialised countries between 5 and 30% of all cases of foodborne *Salmonellosis* are estimated to have pork as the actual source (Berends et al, 1997). Historically, the focus of pork industries has been on *S.* Typhimurium, the most significant serovar in human infection (Mousing et al 1997a; van der Wolf, 2007, Hurd et al 2005; Rostagno et al 2003). However, in Australia *S.* Typhimurium is considerably less evident at slaughter representing only 5% of the isolates from the 1.9% *Salmonella*-positive carcases identified by national monitoring between 2000 and 2006 (Hamilton et al 2007a).

The direct relationship between *Salmonella* carriage rate in the slaughter pig population and carcase contamination has long been accepted internationally and forms the basis of the European (Danish) *Salmonella* monitoring and control programme (Mousing et al 1997b). In line with that view in 1997 Australia developed and validated a *Salmonella* ELISA for slaughter pig surveillance and on-farm control (van der Heijden 2001). Ongoing research since that time, however, has shifted the Australian focus to controls further along the pork supply chain as a more effective approach. This change in direction has been mirrored by international questioning of the cost effectiveness of on-farm control in the live animal, particularly at relatively low *Salmonella* prevalence (Miller 2005, Goldbach & Alban 2006).

Against this background we conducted a study at 2 Australian pig abattoirs to compare two decontamination processes on baconer pig carcases: hot water and acidified sodium chlorite (SANOVA™). The results of the trial are presented in these proceedings.

Materials and Methods

To maximise the potential for carcase *Salmonella* contamination, trial pigs were selected from herds identified as high prevalence by on-farm faecal sampling and were processed late in the slaughter shift. At each abattoir, trial pigs were slaughtered over three days, with a maximum of 150 carcases sampled daily

at the end of the slaughter chain. In total, 852 carcases were sampled by excising and stomaching belly strips, a technique shown to increase the frequency of the *Salmonella* isolation from carcases by a factor of up to 7 (Swanenburg et al 2003; Hamilton et al 2007b). On each sampling day the trial carcases were subjected to one of three alternative treatments: up to 50 carcases standard hygienic slaughter (Controls); up to 50 carcases standard hygienic slaughter plus a final rinse with hot water (83.5°C at Abattoir A, 81.9°C at Abattoir B); up to 50 carcases standard hygienic slaughter plus a final rinse with SANOVA™ sanitising solution (ECOLAB Inc) at ambient temperature. SANOVA™ is a mixture of citric acid and sodium chlorite, which produces the microbiologically active chlorous acid. It is commonly used in the poultry industry (Oyarzabal et al 2004). The order of treatments was rotated on each day in a 3 x 3 Latin-square arrangement. Both hot water and SANOVA™ were applied for approximately 15 seconds per carcase, with hot water being applied as a continuous cascade and SANOVA™ as a pressurised spray.

Laboratory Methods: Each belly strip was collected into a sterile stomacher bag on the slaughter floor. Samples were chilled at 4°C until testing. At the lab the belly strip was weighed and an equal amount of Buffered Peptone Water (Oxoid CM509) added. The belly strip was then stomached for 60 seconds. A 1 mL aliquot was taken to estimate *E. coli* and TVC and the remainder processed for *Salmonella*.

Salmonella: Culture methods followed the Australian Standard (AS 5013.10-2004) with enrichment in Rappaport-Vassiliadis Soy broth (RVS) and Muller-Kauffmann tetrathionate/novobicin broth (MKTTn) and plating on Xylose Lysine Desoxycholate (XLD) and Brilliant Green (BGA) agar plates. Confirmation was by latex agglutination using Serobact™ *Salmonella*. Colonies that were latex agglutination negative were checked by biochemistry (MICROBACT™ 12E). Isolates presumptively identified as *Salmonella* were forwarded for serotyping to the Australian *Salmonella* Reference Laboratory at the Institute of Medical and Veterinary Science, Adelaide.

E. coli and Total Viable Count: From the 1 mL aliquot taken immediately after stomaching, as appropriate, 1:10 serial dilutions of the BPW suspension were prepared in 0.1% peptone diluent and 1 mL from each dilution inoculated onto either Aerobic Plant Count Petrifilm (3M) or *E. coli* Petrifilm (3M) and incubated at 48 h ± 3 h at 35°C ± 1°C. Colonies were identified and counted according to the manufacturer's instructions.

Statistical Analysis

Each abattoir was considered for analysis separately. Fisher's Exact Test was used to test for differences in the prevalence of *Salmonella* and the prevalence of *E. coli* between the three treatments. Data for $\log_{10}$ TVC per gram were analysed by analysis of variance to test for mean differences between the three treatments. In this analysis, positive samples greater than the upper limit of detection (> 250,000 cfu/g) or less than the lower limit of detection (<10 cfu/g) were assumed to be equal to the limit of detection. A Tobit (censored) regression was performed for $\log_{10}$ *E. coli* per gram. This technique allows for the censored nature of the data, allowing the inclusion all observations, including those samples where *E. coli* was undetected, leading to more realistic comparisons between the treatments (Lorimer & Kiermeier, 2007). All analyses were performed in R 2.5.1 (R Development Core Team, 2006).

Results and Discussion

Salmonella: At Abattoir A, no *Salmonella* spp. were isolated from any carcase even though the pigs were sourced from a contaminated herd. At Abattoir B, both the hot water and SANOVA™ treated carcases had a significantly lower prevalence of *Salmonella* contamination (2.7% and 7% respectively) compared to the control (16%, $p<0.001$). The prevalence of *Salmonella* was not significantly different ($p=0.12$) between the hot water and SANOVA™ treatments. For hot water treatment this represents an 83% reduction.

E.coli and TVC: At both Abattoir A and B the E.coli prevalence and the mean log TVC and *E.coli* count were significantly reduced by both the hot water and SANOVA™ treatments compared to the control ($p<0.001$). The greatest impact on *E.coli* and TVC was at Abattoir A with hot water treatment. For *E.coli*

there was an 83% reduction in prevalence and a 1.72 reduction in mean log count. For TVC there was a 2.25 reduction in mean log count. Abattoir A had the highest control levels of E.coli and TVC.

Table 1. Effect of hot water and SANOVA™ treatments on the microbiological status of pork carcases (n= adjusted number tested and connected to new footnote)

		Control	Hot Water	SANOVA	p-value
Abattoir A	Mean $\log_{10}$ TVC [a]	4.06 (0.42)	1.81 (0.55)	2.76 (0.53)	<0.0001
	E. coli prevalence	39/42 (92.9%)	4/41 (9.8%)	5/40 (12.5%)	<0.0001
	Mean $\log_{10}$ *E. coli*[b]	0.89 (0.11)	-0.83 (0.23)	-0.64 (0.11)	<0.001
	Salmonella prevalence	0/50	0/50	0/50	n/a
Abattoir B	Mean $\log_{10}$ TVC [a]	3.00 (0.40)	2.09 (0.77)	2.53 (0.56)	<0.001
	E. coli prevalence	104/150 (69.3%)	32/150 (21.3%)	30/100 (30%)	<0.001
	Mean $\log_{10}$ *E. coli*[b]	0.46 (0.08)	-0.65 (0.11)	-0.61 (0.13)	0.007
	Salmonella prevalence	24/150 (16%)	4/150 (2.7%)	7/100 (7%)	<0.001

[a] Standard deviation in parenthesis

[b] Adjusted mean and standard deviation using censored data

Problems with the transport of samples the 2,000 km from abattoir A to the laboratory on the first 2 days meant that they fell outside the 24 hour time parameter and were not included in the analysis

Organoleptic observations

Hot water: Immediately following the 15-second treatment with hot water, exposed muscle on the carcases had a grey "cooked" appearance, particularly the leg, sternum and neck. Within half an hour they had begun to recover some of their bloom and by the next morning the carcases were almost indistinguishable from untreated carcases. At Abattoir A the treated carcases were judged by the company to be acceptable for export. At Abattoir B there was initial unsought feedback from a retailer that the carcases "appeared a bit different" and required some superficial trimming. Subsequent reduction of the treatment temperature apparently resolved the issue.

SANOVA™: Treatment "whitened" both the skin and the fat, but this was judged by the company to be a potentially positive ascetic improvement, particularly for Asian export markets.

Conclusion

Hot water and chemical decontamination provide effective tools currently available to the Australian pig industry that can significantly improve the microbiological status of pig carcases. The economics of their use requires further investigation.

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